Nicotine & Tobacco Research, Volume 11, Number 2 (February 2009) *111–121*

Commentary

How should we define light or intermittent smoking? Does it matter?

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Introduction

Multiple terms for light and intermittent smokers (LITS), each with a range of definitions, are found in the literature. Because of this wide range of terms and definitions, there has been interest in developing a standard definition of LITS. However, several factors need to be taken into account in setting such a definition.

In the literature, levels of cigarette consumption often serve as a proxy measure for toxin exposure, level of addiction, or level of disease risk. However, for a variety of reasons, consumption may not be a good surrogate for these predictor and outcome measures. Some of these reasons include: differences in tobacco products that may affect exposure, changes in understanding about the levels of tobacco use that sustain addiction, how closely consumption measured as cigarettes smoked per day correlates with other markers of exposure, the effect of compensation (changes in smoking behavior to adjust for changes in nicotine levels or in volume of cigarettes smoked), the nonlinear relationship between consumption and disease risk for some diseases, whether people maintain the same levels of smoking over time, and the meaningfulness of various levels of cigarette consumption if other tobacco products are used concurrently. Public health will need to consider, in light of these factors, whether a categorization of LITS is warranted.

This commentary briefly explores each of these aspects of LITS: (a) the terms used in the literature for LITS and the range of definitions found for each term; (b) the most valid LITS categories based on the stability of the various levels of consumption over time; (c) the validity of using consumption as a surrogate measure of toxin exposure, addiction, disease risk, or program impact; (d) the implications of polytobacco use for consumption being used as such a proxy; and (e) whether better measures exist for exposure, addiction, and disease risk. Finally, recommendations regarding the use of consumption as a predictor or as an outcome variable and possible relevant categorizations are discussed.

What terms are used to describe LITS in the literature, and how has each term been defined?

Multiple terms are used in the literature to describe light or intermittent smokers, but these terms are not defined consistently (Tables 1 and 2). Definitions were often different for studies among adolescent smokers than for those with adult smokers, but this difference in the populations studied does not explain range of definitions noted.

Light smoking has the widest set of definitions, ranging from "denied ever smoking regularly and denied any smoking within the past 30 days" to smoking 1–39 cigarettes per week to smoking 10–20 cigarettes per day (CPD) (Biener & Albers, 2004; Bjartveit & Tverdal, 2005; Borland, Chapman, Owen, & Hill, 1990; Centers for Disease Control and Prevention [CDC], 1994; Choi, Okuyemi, Kaur, & Ahluwalia, 2004; Cohen et al., 1989; Costello et al., 2007; Dwyer, Rieger-Ndakorerwa, Semmer, Fuchs, & Lippert, 1988; Falba, Jofre-Bonet, Busch, Duchovny, & Sindelar, 2004; Godtfredsen, Prescott, & Osler, 2005; Godtfredsen, Prescott, Vestbo, & Osler, 2006; Hatsukami et al., 2006; Janson, 1999; Killen, Fortmann, Telch, & Newman, 1988; Morley, Hall, Hausdorf, & Owen, 2006; Okuyemi et al., 2004; Okuyemi, Ahluwalia, Richter, Mayo, & Resnicow, 2001; Okuyemi, Harris, et al., 2002; Okuyemi, Richter, et al., 2002; Rosengren, Wilhelmsen, & Wedel, 1992; Shiffman, 1989; Shiffman, 2005; Stanton, Papandonatos, Lloyd-Richardson, & Niaura, 2007; U.S. Department of Health and Human Services [USDHHS], 1989; Wilson, Parson, & Wakefield, 1999). Additionally, in two studies, light smoking was defined by a combined quantity/frequency measure (a scaled value for frequency of smoking in the past year multiplied by a scaled value for quantity smoked per day). The trajectory graphed appears to peak at an average of 10 CPD or less (White, Nagin, Replogle, Stouthamer-Loeber, 2004; White, Pandina, & Chen, 2002). In another study, light smokers were those consuming 1–4 g of tobacco per day (with a cigarette equivalent to 1 g; a cheroot, 3 g; and a cigar, 5 g; Prescott, Scharling, Osler, & Schnohr, 2002).

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doi: 10.1093/ntr/ntp010
Advance Access publication on February 20, 2009
Received December 28, 2007; accepted May 9, 2008

Table 1. Various definitions of light smokers (generally categorized by number of cigarettes smoked per day; CPD)

Maximum number of CPD	Light smoker		Very light smoker		Low-rate, low-level, low-rate daily, low-level daily smoker		Chipper[a]	
	Definition	Study	Definition	Study	Definition	Study	Definition	Study
4, 5, or 6			<5	Shiffman et al. (1992)	<5	Zhu et al. (2003)	<5	Presson et al. (2002)
	1–4	Bjartveit & Tverdal (2005)	1–4	Rosengren et al. (1992)				
	≤6	Janson (1999)	≤5 or <6	Hajek et al. (1995), Shiffman (1989)	≤5	Kenford et al. (2005), Owen et al. (1995)	≤5	Brauer et al. (1996), Gilpin et al. (1997), Wellman et al. (2006)
							Average ≤5	Shiffman (1989), Shiffman et al. (1990, 1992), Shiffman, Kassel, et al. (1994), Shiffman, Paty, et al. (1994)
					1–5	Etter (2004)	Average 1–5	Kassel et al. (1994), Sayette et al. (2001)
9 or 10	<10	Okuyemi et al. (2001)						
	1–9	Biener & Albers (2004), USDHHS (1989)						
	≤10 or <11	Costello et al. (2007), Okuyemi, Harris, et al. (2002)			≤10	Arcavi et al. (1994)		
	1–10	Choi et al. (2004), Okuyemi, Richter, et al. (2002, 2004)						
14 or 15	<15	CDC (1994), Falba et al. (2004), Hatsukami et al. (2006)[a], Wilson et al. (1999)			<15	Hatsukami et al. (2006)[a]		
	1–14	Borland et al. (1990), Godtfredsen et al. (2005, 2006)						
	≤15	Killen et al. (1988), Shiffman (2005)						
	5–14	Rosengren et al. (1992)						
20	≤20	Cohen et al. (1989)			1–20	Mucha et al. (2006)		
	10–20	Shiffman (1989)						
					Nondaily, no more than 1 pack/week	Dierker et al. (2007)		
Other	1–39 cigarettes/week	Dwyer et al. (1988)						
					Average ≤5 CPD	Hyland et al. (2005)		
					Group averaged <10 CPD	Zvolensky et al. (2007)		
	≤3–5 g tobacco/day	Prescott et al. (2002)						
	Never regularly, none in past 30 days	Stanton et al. (2007)						
	Considered self a light smoker	Morley et al. (2006)[a]						
	No definition: mapped trajectory	White et al. (2002, 2004)						

Note. CDC = Centers for Disease Control and Prevention; USDHHS = U.S. Department of Health and Human Services. Although most definitions of a social smoker base the definition solely on the situations in which the person smokes, one study defined a social smoker as someone who smoked ≤5 CPD for at least 2 years, never exceeding that consumption for more than a few months (Wellman et al., 2006).

[a]Included other elements in the definition beyond number of cigarettes smoked per day.

Table 2. Various definitions of smokers who do not smoke every day (generally characterized by number of days smoked)

	Occasional smoking		Nondaily smoking		Some-day smoking		Intermittent smoking	
	Definition	Study	Definition	Study	Definition	Study	Definition	Study
Smoked on <30 days of past 30 days	Less than once per month	Paavola et al. (2001)						
	2 in a 2-month period	DiFranza et al. (2000)						
	Last smoked 2–30 days ago	Luoto et al. (2000)[a]						
	1–2 times/month	Paavola et al. (2001)	1–2 days in previous 30	Leatherdale et al. (2007)[a]				
	Less than once per week	Fergusson & Horwood (1995)	<Weekly	McDermott et al. (2007)[a]				
	1–2 times/week	Paavola et al. (2001)						
	1–15 days of past 30 days						1–15 days of past 30 days	McCarthy et al. 2001
	<25 or ≤25 days of past 30 days (or past month)	Okuyemi et al. (2004), Okuyemi, Richter, et al. (2002), Evans (1992)[a]						
	1–29 or <30 days of past 30 (or month), less than daily in past 30 days or month)	Stanton et al. (2007), Stone & Kristeller (1992), Zhu et al. (2003)	<30 of past 30 days	Wortley et al. (2003)[a]				
	Average <1 cigarette/day for past 30 days	Koontz et al. (2004)[a]						
			Smoked during previous 30 days	Leatherdale et al. (2007)[a]				
Qualitative definition	Every few months, weeks, or days	Kenford et al. (2005), Wetter et al. (2004)						
	Less than daily or nondaily	Borland (1994), Etter (2004), Etter et al. (2003), Fornai et al. (2001), Kenford et al. (2005), DiFranza et al. (2000)[a]	At least weekly but not daily	McDermott et al. (2007)[a]			Nondaily	Lindstrom et al. (2002), DiFranza et al. (2007)[a]
	Occasional but not regular; occasional but not daily[a]	Holmen et al. (2000), Hennrikus et al. (1996)[a], Sargent et al. (1998)						
	Smoke some days	Biener & Albers (2004), Gilpin et al. (1997), Hines et al. (1996)	Smoke some days	Gilpin et al. (2005)[a], Hassmiller et al. (2003)[a], Husten et al. (1998)[a], Leatherdale et al. (2007)[a], Tong et al. (2006)[a]	Smoke some days	CDC (1993, 2003)[a], Hassmiller et al. (2003)[a]		
Descriptive definition	Considers self an occasional smoker	McDermott et al. (2007), Morley et al. (2006)						

Note. CDC = Centers for Disease Control and Prevention. Although most definitions of a social smoker base the definition solely on the situations in which the person smokes, one study defined a social smoker as a nondaily smoker who smokes only when others are smoking (Gilpin et al., 2005).

[a]Included other elements in the definition, often regarding lifetime use (≥100 cigarettes or 100 times) and/or additional descriptive definition (smokes some days).

Low-level daily or *low-rate daily* also has a range of definitions from fewer than 5 CPD or no more than 5 CPD (Kenford et al., 2005; Zhu, Sun, Hawkins, Pierce, & Cummins, 2003) to, collectively, the group averaging fewer than 10 CPD (Zvolensky et al., 2007). *Low-rate smoker* is defined more consistently as no more than 5 CPD or 1–5 CPD (Etter, 2004; Owen, Kent, Wakefield, & Roberts, 1995), but *low-level smoker* or *low-level use* has more varied definitions ranging from nondaily or no more than 1 pack per week to 1–20 CPD (Arcavi, Jacob, Hellerstein, & Benowitz, 1994; Dierker et al., 2007; Hatsukami et al., 2006; Hyland, Rezaishiraz, Bauer, Giovino, & Cummings, 2005; Mucha, Stephenson, Morandi, & Dirani, 2006).

Very light smoking is defined fairly consistently as daily smoking of fewer than 5 CPD (Shiffman et al., 1992), 1–4 CPD (Rosengren et al., 1992), or fewer than 6 CPD (Hajek, West, & Wilson, 1995; Shiffman, 1989).

The definition of *chipper* has included relatively consistent consumption levels of fewer than 5 CPD, no more than 5 CPD, and 1–5 CPD, but most definitions include additional qualifiers (e.g., on 2 or more [or 4 or more] days per week, more than weekly, never more than 10 CPD, duration at the level specified for at least 2 years, or never exceeding this consumption for more than a few months; Brauer, Hatsukami, Hanson, & Shiffman, 1996; Gilpin, Cavin, & Pierce, 1997; Kassel, Shiffman, Gnys, Paty, & Zettler-Segal, 1994; Presson, Chassin, & Sherman, 2002; Sayette, Martin, Werz, Shiffman, & Perrott, 2001; Shiffman, 1989; Shiffman, Fischer, Zettler-Segal, & Benowitz, 1990; Shiffman, Kassel, Paty, Gnys, & Zettler-Segal, 1994; Shiffman, Paty, Kassel, Gnys, & Zettler-Segal, 1994; Shiffman et al., 1992; Wellman, DiFranza, & Wood, 2006).

The term *occasional smoker* also has a wide range of definitions, but generally this term refers to nondaily smokers. The variation is in how nondaily smoking is defined: specifically, whether a definition is descriptive but imprecise ("nondaily," "some-day use," "occasional," "occasional but not regularly"); whether a minimum is specified for lifetime consumption (e.g., at least 100 cigarettes or 100 times); or whether the definition is based on cigarettes smoked per day, average number of cigarettes smoked per day, or days or times smoked in a week or a month (Biener & Albers, 2004; Borland, 1994; DiFranza et al., 2000; Etter, 2004; Etter, Le Houezec, & Perneger, 2003; Evans et al., 1992; Fergusson & Horwood, 1995; Fornai et al., 2001; Gilpin et al., 1997; Hennrikus, Jeffery, & Lando, 1996; Hines, Fretz, & Nollen, 1998; Hines, Nollen, & Fretz, 1996; Holmen, Barrett-Connor, Holmen, & Bjermer, 2000; Kenford et al., 2005; Koontz et al., 2004; Luoto, Uutela, & Puska, 2000; McDermott, Dobson, & Owen, 2007; Morley et al., 2006; Okuyemi et al., 2004; Okuyemi, Richter, et al., 2002; Paavola, Vartiainen, & Puska, 2001; Sargent, Mott, & Stevens, 1998; Stanton et al., 2007; Stone & Kristeller, 1992; Wetter et al., 2004; Zhu et al., 2003).

Conversely, the term *some-day smoker* has been defined consistently as having ever smoked 100 cigarettes during the smoker's lifetime and currently smoking on some days (not every day; CDC, 1993; Hassmiller, Warner, Mendez, Levy, & Romano, 2003). *Intermittent smoking* has been defined as not smoking on a daily basis (DiFranza et al., 2007; Lindstrom, Isacsson, & the Malmo Shoulder-Neck Study Group, 2002) or as smoking on 1–15 days in the previous month (McCarthy, Zhou, & Hser, 2001). *Nondaily smoker* has been defined as smoking at least weekly (but not daily) or less often than weekly; smoking at least 100 cigarettes in the lifetime and currently smoking some days; smoking more than 100 cigarettes in the lifetime, currently smoking some days, and smoking on fewer than 30 of the past 30 days; smoking more than 100 cigarettes in the lifetime and smoking some days or 1–2 days in the previous 30 days; or smoking fewer than 100 cigarettes in the lifetime and smoking in the previous 30 days (Gilpin, White, & Pierce, 2005; Hassmiller et al., 2003; Husten, McCarty, Giovino, Chrismon, & Zhu, 1998; Leatherdale, Ahmed, Lovato, Manske, & Jolin, 2007; McDermott et al., 2007; Tong, Ong, Vittinghoff, & Perez-Stable, 2006; Wortley, Husten, Trosclair, Chrismon, & Pederson, 2003).

More recently, the term *social smoker* has been used and defined as smoking fewer than 5 CPD in the last 2 years and never exceeding that level of consumption for more than a few months; as a self-reported description of themselves as a social smoker; or as a self-reported description of mainly smoking with others or while partying or socializing (with or without an additional constraint on whether they smoke daily; Biener & Albers, 2004; Gilpin et al., 2005; Moran, Weschler, & Rigotti, 2004; Morley et al., 2006; Waters, Harris, Hall, Nazir, & Waigandt, 2006; Wellman et al., 2006).

Finally, *never daily smoking* has been defined as having never smoked daily for 6 months or more (Gilpin et al., 1997) or current or former smokers (defined as having ever smoked at least 100 cigarettes in the lifetime) and never smoked daily (Husten et al., 1998).

What are the most valid LITS categories based on the stability of the various levels of consumption over time?

The stability of the behavior within any definitional category or categories of LITS is an important consideration in determining a definition of the term. If smokers do not maintain the same level of consumption over relatively short timeframes, the relevance and importance of the categorization is questionable. The stability of CPD categories is particularly a problem for LITS because people in this group constitute a heterogeneous set of smokers. Some (particularly adolescents and young adults) are initiating smoking, some are cutting back either because of a desire to reduce exposure or as a prelude to quitting, and some have maintained a low level of consumption over a protracted period of time. Any definitions of LITS should try to capture the more stable categories within this heterogeneous group.

To date, several studies have examined the stability of various categories of LITS consumption. For example, Etter et al. (2003) examined changes in smoking status more than a 7-month follow-up among daily smokers aged 15 years or older. Among those smoking 1–5 CPD at baseline, only 45% were smoking 1–5 CPD at follow-up. Thus, their levels were much less stable than those of smokers who consumed at least 16 CPD, of whom 80% were smoking at the same level at follow-up. Zhu et al. (2003) examined smoking status at 2 years follow-up for low-rate (≤5 CPD) smokers. Low-rate smokers were the least stable group: only 36% remained low-rate smokers

at the 20-month follow-up compared with 82% stability among regular smokers (>5 CPD). Hyland et al. (2005) reported that among those who were low-level smokers (≤5 CPD), only 28% were low-level smokers 5 years later. Among those who were low-level smokers at both timepoints, 47% were still low-level smokers 13 years after the original assessment (14% of the original cohort). Janson (1999) followed children from age 12 (in 1967) to age 36 and found that light smoking (≤5 CPD) did not remain stable after adolescence; rather, as age increased, low-intensity smoking because less frequent and almost disappeared by older ages.

Lindstrom et al. (2002) assessed intermittent smokers (defined as nondaily smokers) at 1-year follow-up and reported that 60% remained intermittent smokers. Similarly, Evans et al (1992) reported that 60% of occasional smokers had been occasional smokers 1 year previously. In contrast, Hines et al. (1996) reported that only about one-third of occasional smokers remained occasional smokers at 1-year follow-up, and McCarthy et al. (2001) reported that only 16% remained intermittent smokers at 1-year follow-up. (Because McCarthy et al. was a study of polydrug users, patterns are likely different from those in the general population of smokers.) Hennrikus et al. (1996) conducted a longitudinal study and reported that, among occasional smokers at intake, 43% remained occasional smokers more than 2 years. More recently, Zhu et al. (2003) examined smoking status at 2 years of follow-up for occasional (not daily smoking in the past 30 days) and reported that 44% of these smokers were still occasional smokers at that point. However, McDermott et al. (2007) reported that only 12% of young adult women maintained occasional smoking status more than 2 years. Wetter et al. (2004) examined college-aged occasional smokers; 35% remained occasional smokers more than 4 years. Hassmiller et al. (2003) looked at changes in smoking status among some-day (nondaily) smokers and found that 45% had a stable pattern more than 1 year and 34% had stable consumption levels for more than 5 years. Stanton et al. (2007) reported that 20.5% of adolescent occasional smokers were occasional smokers 6 years later.

Among a group of intermittent adult smokers who had never engaged in daily smoking, the prevalence of continued intermittent smoking at 1-year follow-up was 87% (Husten et al. 1998). Similarly, Hassmiller et al. (2003) found that only 25% of long-term, stable, nondaily users had ever been daily smokers. Thus, based on current studies in the literature, intermittent smoking (particularly among those who have never smoked daily) appears to be the most stable of the LITS categories among adults.

Is cigarette consumption a valid measure of exposure to toxins?

The characteristics of cigarettes can affect exposure to nicotine and to the toxins and carcinogens in the product. For example, nicotine levels vary by cigarette, with a new cigarette, Quest 3, having just trace amounts of nicotine. This is in contrast to low-tar cigarettes, which allow extraction of higher doses of nicotine and toxins than machine-yield data would suggest (National Cancer Institute, 2001). Cigarettes also vary in their design characteristics, such as their level of filter ventilation, which can affect the amount of readily absorbed un-ionized nicotine (Watson, Trommel, & Ashley 2004). Some cigarettes are marketed as containing lower quantities of certain carcinogens and toxins, but studies suggest that reductions in human exposure are less than the reductions reported in the products themselves (Benowitz, Jacob, Kozlowski, & Yu, 1986; Djordjevic, Stellman & Zang, 2000; Godtfredsen et al., 2005, 2006; Hatsukami et al., 2006; Hecht et al., 2004).

How people smoke also affects the dose of nicotine, toxins, and carcinogens obtained from the product. For example, the number of puffs taken from each cigarette; duration, volume, and intensity of the puffs; inhalation volume; how long the puff is held; duration of lung exposure; and percentage of puff inhaled are variables that can affect the amount of chemicals absorbed and the rapidity of such absorption for any given level of cigarette consumption (USDHHS, 1988). Thus, different smokers may have different exposure levels for the same number of cigarettes per day because of how they smoke the cigarettes (Hatsukami et al., 2006). Individuals may vary how they smoke, and this may depend on whether they are smoking a low-tar or full-flavor cigarette, whether it is their usual brand, or even the time of day or the time since their last cigarette (Djordjevic, Hoffmann, & Hoffmann, 1997; USDHHS, 1988).

Because of compensation (National Cancer Institute, 2001), smokers who have cut back their cigarettes per day to a particular number may have different exposure than smokers consuming the same number of cigarettes per day who always smoked at that level (Hatsukami et al., 2006). Smokers who cut down typically smoke the cigarettes more intensely to maintain nicotine levels and, therefore, have higher exposure to the toxins in cigarettes than users who smoke the same number of cigarettes per day but have always smoked at that level (Shiffman et al., 1990). Thus, studies have reported that reduction in toxin exposure is generally less than would be expected by reductions in the number of cigarettes smoked (Benowitz et al., 1986; Djordjevic et al., 2000; Godtfredsen et al., 2005, 2006; Hatsukami et al., 2006; Hecht et al., 2004; Hurt et al., 2000). The issue of reductions in consumption and compensation may become more important as smoke-free policies become more common; these policies have been shown to reduce the number of cigarettes smoked per day (Biener, Abrams, Follick, & Dean, 1989; Borland et al., 1990).

In summary, variability in the properties of cigarettes themselves can affect exposure to nicotine, toxins, and carcinogens; within-person (intrapersonal) and between-person (interpersonal) variability can lead to differences in exposure to the chemicals in cigarette smoke; and variability in the metabolism of nicotine and the various chemicals in cigarettes leads to differences in exposure. These factors make cigarette consumption a crude and likely inaccurate measure of exposure.

Is cigarette consumption a valid measure of addiction?

Historically, it was believed that smokers must smoke daily and probably consume more than 5 CPD to maintain steady-state blood nicotine levels and nicotine dependence (Benowitz & Henningfield, 1994; Shiffman, 1991). Shiffman (1989), for example,

has argued that "chippers," who have smoked low daily levels over long periods of time, do not manifest signs of nicotine dependence. However, recent studies have challenged the premise that sustained nicotine levels are required for addiction and have suggested that some indicators of dependence, particularly loss of autonomy, can be seen after only a few cigarettes have been smoked (DiFranza et al., 2000, 2002, 2007; O'Loughlin et al., 2003). Dierker et al. (2007), using *Diagnostic and Statistical Manual of Mental Disorders* (4th edition) criteria, reported that some nondaily college-aged smokers were nicotine dependent and, conversely, that not all daily users in this group were nicotine dependent. Nicotine dependence likely occurs on a general continuum from lower to higher levels of use, but widespread variability exists. Because of the frequent lack of concordance between consumption and dependence, cigarette consumption is generally not used as the sole criterion for dependence. Instead, behaviors such as stereotypic patterns of use, use despite harmful effects, relapse following abstinence, and recurrent craving are important criteria for addiction (USDHHS, 1988). Concurrent use of nicotine replacement therapy or other tobacco products while smoking could lower cigarette consumption without reducing nicotine dependence, making cigarettes smoked per day an even poorer surrogate for addiction level.

Adding to the complexity of how to relate dependence to patterns of smoking, nicotine metabolism varies among individuals. For example, Blacks have higher cotinine levels than Whites for a particular number of cigarettes smoked per day (Caraballo et al., 1998). Black smokers have lower metabolic clearance of cotinine and of nicotine than do Whites (Perez-Stable, Herrera, Jacob, & Benowitz, 1998). As a result, although Blacks tend to smoke fewer cigarettes per day, this does not necessarily mean lower levels of nicotine dependence. Similarly, individual people metabolize the toxins and carcinogens in tobacco differently, likely leading to different levels of absorption and activation of these chemicals and individual differences in disease risk for the same level of consumption (Liu, Zhou, & Christiani, 2005).

In summary, variability in the properties of cigarettes themselves can affect nicotine absorption, and variability in the metabolism of nicotine leads to differences in nicotine levels for the same exposure. Additionally, individuals' genetic makeup may influence their susceptibility to becoming nicotine dependent (Lerman & Berrettini, 2003). Thus, cigarette consumption appears to be a crude measure of nicotine dependence.

Is cigarette consumption a valid measure of disease risk?

There is no safe level of smoking as even people who have always smoked at low levels have an increased risk of adverse health effects. Even with relatively brief and low-dose exposure, such as from secondhand smoke exposure, changes occur in platelet activation and endothelial cell function (USDHHS, 2006), and cardiovascular risk, in particular, appears to increase rapidly with low levels of exposure or consumption (Pechacek & Babb, 2004). Teo et al. (2006) reported a risk of 1.53 (nonsmokers as the referent) for persons smoking 1–9 CPD and a linear risk with increasing consumption (5%–6% increase in risk for every cigarette smoked per day). Prescott et al. (2002) reported that women consuming 3–5 g of tobacco per day (a cigarette was 1 g and a cigar 5 g) had relative risks (*RR*s) of 2.14 for myocardial infarction and 1.86 for all-cause mortality. Men consuming 6–9 g per day had *RR*s of 2.10 and 1.76, respectively (again with nonsmokers as the referent). Bjartveit and Tverdal (2005) reported an increased risk of dying of cardiovascular disease (CVD), all-cause mortality, and lung cancer in women smoking 1–4 CPD. Similarly, the Nurses Health Study (Willett et al., 1987) found an *RR* of cardiac death of 2.5 with consumption of 1–4 CPD. Rosengren et al. (1992) also reported that those smoking 1–4 CPD had an increased risk of a cardiac event ($RR = 2.8$) and no greater risk at higher levels of smoking. Luoto et al. (2000) reported that after 18 years of follow-up, occasional smokers had an increased *RR* (1.6) for total mortality and for CVD mortality (1.5) and that CVD risk was comparable for light and heavier smokers. Godtfredsen, Holst, Prescott, Vestbo, and Osler (2002) reported that smokers who reduced their consumption by 50% had no reduction in CVD, respiratory diseases, tobacco-related cancers, or all-cause mortality compared with continuing heavy smokers.

Some studies have reported a lower risk of lung cancer with reductions in cigarette consumption of 50%, although the percent reduction in risk was smaller than was the reduction in consumption (Godtfredsen et al., 2005). Additionally, Doll and Peto (1978) reported that duration of smoking is a much stronger risk factor than amount smoked. More recently, Godtfredsen, Vestbo, Osler, & Prescott, (2002) reported that reducing cigarette consumption by 50% did not decrease hospitalization for chronic obstructive pulmonary disease in a comparison with continuing heavy smokers. Wilson et al. (1999) found that light smokers (defined as <15 CPD) had a lower quality of life than nonsmokers and scored worse than former smokers on three of four dimensions of mental health.

In summary, significant health risks are associated with smoking as few as 1–4 CPD. Although less research has examined the risks from nondaily smoking, one study (Luoto et al., 2000) showed increased cardiovascular risk and total mortality in this group in comparison with never-smokers. Risk for CVD occurs at very low levels of exposure to cigarette smoke (such as exposure to secondhand smoke), and even these low levels of exposure to cigarette smoke result in exposure of target organ DNA to a large number of metabolically active carcinogens (USDHHS, 2006). Thus, in terms of disease risk, no level of consumption could be considered "safe," and no threshold of risk could help to inform a definition of LITS.

Is cigarette consumption a valid measure of program impact?

One effect of comprehensive tobacco control programs is decreased cigarette consumption, both per capita consumption and in average number of cigarettes smoked per day (Abt Associates, 2000; California Department of Health Services, 2001; Gilpin & Pierce, 2002). Thus, both per capita consumption (from data gathered from tax stamps) and individual consumption levels have been widely used as markers of program impact (Farrelly, Pechacek, & Chaloupka, 2003; USDHHS, 2000). A lower prevalence of heavy smoking and a higher prevalence of

intermittent (nondaily and some-day) smoking both correlate strongly with lower overall state smoking prevalence (Giovino, 2004).

What are the implications of polytobacco use for using cigarette consumption as a proxy for exposure, addiction, or disease risk?

The findings in one study suggest that a substantial proportion of concurrent use of other tobacco products is found among LITS. Specifically, Okuyemi et al. (2004) reported that 40% of (Black) occasional smokers and 23% of light smokers used other tobacco products. Recent promotions of smokeless tobacco as a product to use when people are unable to smoke have the potential to make concurrent use of multiple tobacco products even more common. Thus, it is plausible that total tobacco use and nicotine levels might be maintained even with cigarette consumption at lower levels. Measures of cigarette consumption alone would be misleading under these circumstances, and consumption would be even less valid as a proxy measure of exposure, addiction, or disease risk. Concurrent use of cigarettes and other tobacco products could expose the user to higher quantities and/or different toxins than if they used cigarettes alone and potentially result in a higher disease risk than would be expected based on the reported number of cigarettes smoked per day. Polytobacco use also implies the need for detailed information about the levels of consumption of all tobacco products being used.

Are there better measures than cigarette consumption (as defined by cigarettes per day) for exposure, levels of addiction, and/or disease risk?

Before developing a "uniform" definition for LITS, we should determine what we are trying to measure and whether the number of cigarettes smoked per day is the best way to measure it. To measure exposure, levels of cotinine or other biomarkers may be better options because these measures could reflect all tobacco products being consumed and the specific exposure of interest. If we are trying to measure addiction, questions that address loss of control may be better measures. For measuring disease risk, biomarkers of disease may be more relevant (although there are none specific to tobacco at present). The use of multiple tobacco products makes CPD alone an incomplete measure for tobacco use as well.

Are there alternative ways to measure consumption? One study used "grams of tobacco consumed" as a way to measure total consumption. Although a possible way to assess use in people consuming multiple tobacco products, this measure does not account for the possibility that various brands may differ in their amounts of tobacco, products change over time, and different manufacturing processes may result in differential exposure to toxicants for the same tobacco weight or volume. Additionally, route of exposure (inhalation vs. oral) may be relevant to the health risks incurred by the user, particularly because burning tobacco introduces toxins other than those from the tobacco itself. However, the experience of a century of cigarette use led the Surgeon General to conclude that the toxins and carcinogens to which the user is exposed "go wherever the blood flows" (USDHHS, 2004) and that the diseases caused by tobacco extend beyond organs directly exposed to tobacco or tobacco smoke. Thus, route of consumption may be less important than total exposure to tobacco toxicants and carcinogens.

Should we continue to use categories of cigarette consumption (cigarettes per day) as a predictive or outcome measure?

Levels of cigarette consumption have often served as a proxy for exposure, addiction levels, disease risk, and the impact tobacco control interventions. However, as knowledge of the product, people's tobacco-use behavior, biomarkers of exposure and disease, and mechanisms of disease has improved, the limitations of this measure have become clearer. Because measures of exposure, addiction, disease risk, and the impact of interventions are all important, specific measures for each will likely be needed. However, monitoring consumption can still provide one indication of overall changes in social norms for the use of cigarettes and for the impact of various programs to limit their use. For both research studies and national surveys, consumption should probably be analyzed as a continuous variable, rather than by establishing a priori cutpoints, because there do not appear to be well-defined consumption levels that correlate with the onset of addiction or disease risk.

In summary, among the various LITS categories, daily versus nondaily use appears to be the most useful. Nondaily use appears to be the most stable of the LITS categories. Nondaily use is also the category where the definitions used in existing studies are the most consistent, and similar definitions are also found in national and state surveys (CDC, 1993, 2003), allowing comparability between research studies and data from these surveys. Nondaily use can also be captured with a single question, unlike more detailed consumption levels (which require questions about number of days per week the product is used and the amount consumed on those days). Using a simple measure also means that other survey questions can be devoted to assessing the use of non-cigarette forms of tobacco and obtaining a more complete assessment of all tobacco used.

However, researchers should use the most specific measures available for the particular construct in question (e.g., exposure, disease risk, addiction), rather than using cigarettes per day as a surrogate. Since addiction, exposure, and disease risk operate along a continuum with no apparent lower threshold level, it is also recommended that researchers analyze individual consumption data (CPD) as a continuous rather than as a categorical variable.

Funding

None declared.

Declaration of Interests

None declared.

Acknowledgments

The author thanks Jamilyn Renna, for her diligence in tracking down references, and Patricia Richter, for her thoughtful comments on the draft manuscript.

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